ENERGY UPDATE

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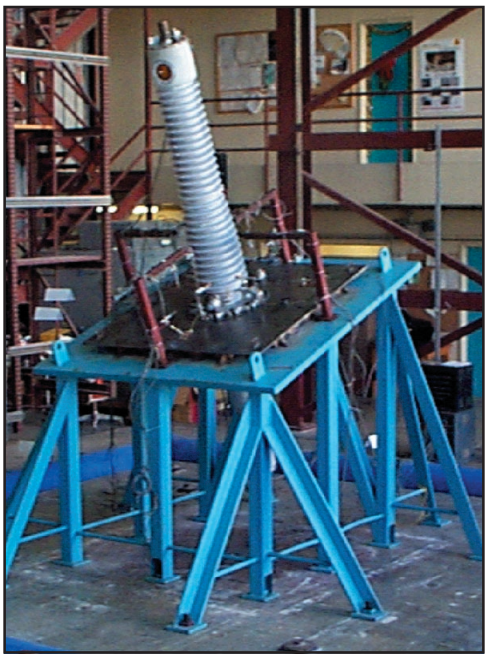
Electric System Seismic Safety and Reliability Success Story

In California, it is never a matter of "if" an earthquake will happen. It is a matter of "when." In the event of a major earthquake, first responders are key players in managing emergency situations. Police officers, emergency operators, hospital emergency room personnel, and fire fighters are just a few of the people who are called in to help when the inevitable events occur. But before these and other emergency personnel can even begin to do their jobs properly, there is one thing that each one of them needs - electric power.

Thanks to research sponsored by the California Energy Commission's Public Interest Energy Research (PIER) Program and Pacific Gas and Electric Company (PG&E), and conducted by the Pacific Earthquake Engineering Research Center at UC Berkeley (PEER), new tools and methods are being developed to make electric power transmission more reliable in the event of a major seismic event in California. When it comes to construction standards, there is no place on earth that can match California in preparing for an earthquake. When it comes to predicting what will happen to the electric grid during the course of an earthquake, energy leaders in California continue to strive to make the system perform the best it possibly can.

Among the areas under study are the substations that receive and distribute electricity to large areas of the state. The major causes of outages during past earthquakes were the catastrophic failures of circuit breakers, transformer bushings and disconnect switches at the substations. Here are some of the ways PEER researchers are currently working to make the system even more reliable:



Transformer bushings are tested by subjecting them to simulated earthquakes, as shown here on the PEER shaking table.

Substation Porcelain Transformer Bushings

Throughout most of California and the nation, high voltage wires leading into substation transformers are insulated by a porcelain bushing on top of the transformer. This material is very brittle, and researchers are testing new composite materials and anchorage designs for these bushings to help prevent their destruction during future earthquakes. This results in a cost avoidance to PG&E of approximately $100,000/year. Based on these results, PG&E now procures only 500kV composite bushings for new orders. Not only are these bushings more rugged during earthquakes, they require less maintenance as well.

Although the bushings can be replaced after an earthquake, the loss of a 500kV substation could not only affect electricity in California, but possibly disrupt service in surrounding states. Also, the repair of substations could involve a significant amount of time – at the very least, several hours – during the crucial time following a disaster.

Fragility Testing – 500kV and 230kV Disconnect Switches

Like the electric circuits in our homes, substations are equipped with disconnect switches, which are used for routing power to the desired circuit, or shutting down an electrical line for a variety of reasons – whether it be damaged equipment, routine maintenance or a downed power line. Any time work is done on

(Cont.)

The properties of flexible strap connectors (such as this S-shaped one) can be important for the seismic response of the station equipment they connect.

power lines in your neighborhood, a disconnect switch is used to shut down a specific area for the safety of the workers. As you might imagine, there are thousands of these switches in the State of California.

Like everything else, these switches must survive an earthquake for the system to remain functional. PEER researchers are hard at work in developing a more cost-effective and resilient disconnect switch/support system, hoping to reduce the damage during a seismic event. This research has provided valuable data for the development of new industry standards that will help to reduce damage to these important substation components and other equipment in the event of a major earthquake. The implementation of these new industry standards has resulted in achieving superior performance of 230 kV disconnect switches with minor modifications. Costs avoided by not having to purchase more expensive switches are estimated to be $250,000/ year to PG&E alone.

Rigid & Flexible Conductor Studies

The Electric System Seismic Safety and Reliability project is also researching the effects of seismic motions on the conductors, or busses, that connect substation equipment. Rigid busses and connectors tend to transfer damaging motions during earthquakes to more fragile equipment such as transformer bushings.

New flexible connectors, such as the 'S'-shaped flexible strap connector - which may "bend, but not break during an earthquake," - are being tested at this time to evaluate their effectiveness in minimizing damaging motions to substation components. This design, developed by UC Berkeley and being considered for patent, will help to improve substation performance during earthquakes.

Conclusion

In California, earthquakes are inevitable. The damage caused by earthquakes is not. Through research and development, demonstration and implementation, the State of California leads the world in preparation and prevention of damage through collaborative projects like the California Energy Commission's Electric System Seismic Safety and Reliability project. By continuing to make our electric system even more reliable during a major seismic event, the California Energy Commission is committed to reducing the damage to the power system in an earthquake and helping emergency personnel carry on with their tasks

Shake table testing of a 500 kV disconnect switch at the PEER Richmond field station.

during a potentially dangerous situation. In addition, faster post-earthquake resumption of utility services will enable a timely resumption of normal business operations, which benefits both the California and national economies.

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